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Attorney's Docket No.: 02103-397001 / AABOSS28

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	: J. Richard Aylward, et al.	Art Unit	: 2644
Serial No.	: 09/735,123	Examiner	: Andrew R. Graham
Filed	: December 12, 2000		
Title	: PHASE SHIFTING AUDIO SIGNAL COMBINING		

Mail Stop Appeal Brief - Patents
Hon. Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

(i) Real Party in Interest.

Bose Corporation

(ii) Related Appeals and Interferences.

None.

(iii) Status of Claims.

Claims 1-23 being appealed stand rejected under 35 U.S.C.§112, first paragraph, and failing to comply with a written description requirement, claims 1-17, 20, 22 and 23 also stand rejected under 35 U.S.C.§103(a) as being unpatentable over Robinson as a primary reference in view of Griesinger as a secondary reference and Waller as a tertiary reference claim 21 also stands rejected under 35 U.S.C.§103(a) as being unpatentable over Robinson as a primary reference in view of Griesinger as a secondary reference, Waller as a tertiary reference and Kuusama as a quaternary reference and claims 18 and 19 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

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(iv) Status of Amendments.

None filed. It is expected that an amendment will be filed rewriting allowable claims 18 and 19 in independent form.

(v) Summary of Claimed Subject Matter.

The invention involves combining a first audio signal from a first audio channel, such as 12 in FIG. 3a, and a second audio signal from a second audio channel, such as 14. The first and second audio signals have a first, such as bass, and second, such as above bass frequency range. The phase of the first audio signal relative to that of the second audio signal is shifted a constant amount substantially limited to the first frequency range from about 20Hz to about 500Hz. The relatively phase-shifted audio signal from the first channel is combined with the audio signal from the second channel, such as in combiner 16, to provide a combined bass frequency signal with a range of phase shifting being between about 60 degrees and about 120 degrees, and electroacoustically transducing the combined bass signal, such as with a nonlocalized bass module. Page 4, lines 7-23.

An audio system comprises an audio signal source constructed and arranged to provide a first channel signal and second hands signal, such as on audio claimed input lines 12 and 14 respectively, in FIG. 3a, and a phase shifter or phase shifting correcting coupled to the audio signal source for shifting by a constant phase angle the phase of the first channel signal relative to the second channel signal constructed and arranged to substantially limit the phase shifting in the first range of frequencies only over a first range of frequencies between about 20Hz to about 500Hz with a range of phase shifting between 60 degrees to about 120 degrees, such as phase shifter 78, a combiner constructed and arranged to combine the relatively phase-shifted first channel signal and second channel signal to provide a combined bass signal, such as combiner 6 and electroacoustical transducuing apparatus constructed and arranged to transduce a combined bass audio signal into a bass acoustic signal, such as with a nonlocalizable bass module. Page 4, lines 7-23. (use alternate term sounding claim 14 also, such as first and second audio channel input, phase shifting circuitry.)

(vi) Grounds of Rejection to be reviewed on appeal.

1. Whether claims 1-23 fail to comply with the written description requirement of 35 U.S.C.§112 when the specification discloses the relative phase shifts can be nonuniform or uniform on page 3 and identifies 90 degrees as a specific constant on page 6.

2. Whether claims 1-17, 20, 22, and 23 are unpatentable under 35 U.S.C.§103(a) over Robinson as a primary reference, Griesinger as a secondary reference and Waller as a tertiary reference when the references fail to suggest the desirability of combining what is there disclosed to meet the terms of these claims.

3. Whether claim 21 is unpatentable under 35 U.S.C.§103(a) over Robinson as a primary reference, Griesinger as a secondary reference, Waller as a tertiary reference and Kuusama as a quaternary reference when the references fail to suggest the desirability of combining what is there disclosed to meet the terms of this claim.

(vii) Argument.

I. CLAIMS 1-23 MEET THE WRITTEN DESCRIPTION REQUIREMENT OF 35 U.S.C.§112, FIRST PARAGRAPH, AT LEAST BECAUSE PAGE 3 OF THE WRITTEN DESCRIPTION DISCLOSES THE RELATIVE PHASE SHIFTS CAN BE NONUNIFORM OR UNIFORM AND PAGE 6 OF THE WRITTEN DESCRIPTION DISCLOSES A SPECIFIC CONSTANT PHASE SHIFT OF 90 DEGREES.

The final action states:

> 3. Claims 1-23 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.
>
> Claims 1, 11, and 14 each include the limitations of "said shifting is constant" or "shifting by a constant phase angle". The examiner respectfully submits that the scope associated with such wording of a limitation is new matter. This "constant" shifting is interpreted herein to mean that, over the given frequency range, the amount of phase shift does not change based on the frequency. This is based in part by the fact that the applicant argues that the previously applied reference, Robinson, does not teach such a "substantially constant phase shift", citing Figure 2, and col. 4, lines 35-41. The phase shift in the reference of Robinson, illustrated by line 52 in Figure 2, varies by only 10°

over the frequency range of 20-5000 Hz. Thus, to argue that this phase shift is not "substantially constant" would mean that the scope of the applicant's phase shift is less than 10°, or 00, as is denoted by the word "constant". It is further noted that "substantially constant" listed in the remarks, is considered herein to be different in scope than "constant" This "constant" phase shifting does not appear to be supported by the specification. Specifically, the paragraph of the specification that begins at the bottom of page 5 and continues to the top of page 6 states that "the phase shift is preferably 60 to 120 degrees over the frequency range of interest" and it is desirable "to have most in the frequency range relatively shifted by close to 90 degrees". These phrases are not interpreted to mean an exact, invariant angular degree, but rather, an angular degree that varies over the given frequencies. The discrepancy is further illustrated by Figures 5a and 8b of the present application, both of which show a phase shift that changes depending on frequency. The applicant is respectfully requested to delete this limitation from the cited claims or amend the limitation such that it corresponds to the scope supported by the specification.

Claims 2-10, 12-13, and 15-23 are rejected due to their respective dependencies upon rejected claims. Pp.2-4.

The sentence beginning at line 29 of page 3 reads, "The relative phase shifts can be non-uniform or uniform according to a pattern, for example, by shifting each channel by i (360/n) degrees (where i=0 to n-1, or i=1 to n)." The sentence beginning on line 23 of page 6, of the written description reads, "With regard to the invention, if the phase shift difference applied by the circuitry is 90 degrees, the resultant combined signal consists of two components with a phase difference of 90 degrees, regardless of whether the two input signals were in phase or out of phase before being combined."

II. CLAIMS 1-17, 20, 22 AND 23 MEET THE CONDITIONS FOR PATENTABILITY UNDER 35 U.S.C.§103(A) AT LEAST BECAUSE THE PRIMARY, SECONDARY AND TERTIARY REFERENCES FAIL TO SUGGEST THE DESIRABILITY OF COMBINING WHAT IS THERE DISCLOSED TO MEET THE LIMITATIONS OF THESE CLAIMS.

The final action states:

4. Claims 1-17, 20, and 22-23 are rejected under 35U.S.C. 103(a) as being unpatentable over Robinson (USPN 4356349) in view of Griesinger (USPN 6683962) and Waller, Jr (USPN 5333201). "Waller, Jr" will hereafter be referred to as "Waller". Robinson discloses a method and apparatus for enhancing a stereo signal. Such a system, as illustrated in Figure IA, involves the modification of two different input signals on two input lines (20,24) (col. 4, lines 1-4). These two

signals, derived initially from stereo audio signals, read on "a first audio signal from a first audio channel and a second audio signal from a second audio channel" (col. 3, lines 58-61).

Specifically, the sum signal (20) is equated herein to "a first audio signal from a first audio channel" and the difference signal (line 24) is equated to "a second signal from a second audio channel" (col. 4, lines 1-4). The modifier network (30) for one of the signals introduces a small time delay to the low frequency component of the signal, which in terms of sinusoidal signals is equivalent to a phase shift (col. 4, lines 11-17). Robinson discusses the signal in terms of various frequency ranges, including 30 to 250 Hz, and higher than 250 Hz (col. 4, lines 36-40). This reads on "said first and second audio signals having a first and second frequency range". The result of this phase shifting is shown in Figure 2 as curve 52 (col. 4, lines 34-36). This modification of the particular frequency range between two low levels of frequency shift reads on "shifting the phase of said of said first audio signal relative to said second audio signal". As can be seen in Figure 2, this phase shift is relatively minor, the shown values varying from 2° to a maximum of 9° (col. 4, lines 36-40). In view of the definition of "constant" discussed above, this reads on "said shifting is constant". After modification, the two signals are combined with a summing network (34), which reads on "combining the audio signal from said first channel with the audio signal from the second channel".

However, Robinson does not specify:

- that the frequency range over which the relative phase is applied is from about 20 Hz to about 500 Hz

- that the combined bass frequency signal with a range of phase shifting being between about 60 degrees and about 120 degrees

Griesinger teaches a system of signal processing for providing a richer, fuller bass sound by exciting more room modes than conventional systems. Griesinger teaches that the spaciousness of an audio signal below 500 Hz is more complicated than in higher frequencies, and that the maximum spaciousness is obtained with the excitation of all resonance modes in a listening area (col. 8, lines 42-55; col. 9, lines 50-61; col. 15, lines 5-16). A relative phase shift of approximately 90° is disclosed as the solution for maximally exciting all room modes (col. 15, lines 43-45 and col. 16, lines 41-49). Griesinger

teaches that constant phase shifting networks are well known in the art, and are generally arranged to approximate a 90° phase shift over a given range of frequencies, such as 20-200 Hz (col. 15, lines 17-23). Griesinger also teaches that, ideally, the phase shift is zero above 400° (col. 15, lines 26-27). Figure 15 illustrates circuitry used in implementing such a phase shift (col. 15, lines 46-48). Curve B of Figure 16 illustrates thephase relationship that results from a simulation of the output of such circuitry. The shown shift is within 14° of 90° from 150 Hz to 200 Hz, at approximately 45° at 300 Hz, 30° at 500 Hz, and 20° at 1000 Hz. The disclosure of a nearly constant phase shift over a decade of "20 Hz and 200 Hz" equates to 'said shifting is constant and substantially limited to said

first frequency range from about 20 Hz to about 500 Hz", though it is noted that other frequency ranges associated with the simulation of Figure 16 may be interpreted as "about 20 Hz" and "about 500 Hz". The phase shift of within 14° of 90° for the simulation of Figure 16 and the other phase shift ranges shown in Figure 16 for the ranges discussed above reads on 'with the range of phase shifting being between about 60 degrees and about 120 degrees".

To one of ordinary skill in the art at the time the invention was made, it would have been obvious to incorporate the phase shifts disclosed by Griesinger as the phase shifts applied by the system of Robinson. The motivation behind such a modification would have been that such phase shifts would have increased the apparent spaciousness of sounds reproduced in a room by the speakers, based on the excitation of all modes of the room and the corresponding creation of an interaural time difference. A boost stage is also included in the system for equalizing the output response for the low frequencies.

The satellite/subwoofer (5,6,8,9) speaker system of Griesinger suggests that a bass frequency portion of the processed signal is desirable (col. 4, lines 56-61). However, neither Robinson nor

disclose a method for deriving such a signal.

Robinson in view of Griesinger does not clearly specify:

- that the combining of the relatively phase shifted audio signals produces a combined bass frequency signal, wherein the term "bass frequency signal" is interpreted to only include signals from the bass frequency range

Waller discloses a system that derives improved sound directionality. This is accomplished through the isolation of various frequency ranges of the received signal and the appropriate adjustment of their output characteristics, such as amplitude (col. 5, lines 25-34; col. 6, lines 28-43). Figure 1 illustrates an embodiment of the system wherein high pass filters (21,31) and low pass filters (22,32) are used to separate the received signal into two frequency ranges, wherein the high frequency range component is altered with an in-path voltage controlled amplifier (col. 6, lines 28-48). The two low pass

filtered signals are provided directly to a pair of summing amplifiers (40R,40L), an alternate embodiment of which is shown in Figure 6 (col. 9, lines 55-57). Figure 6 illustrates the use of all-pass filters, which are also used in the system of Griesinger (col. 9, lines 23-27). Figure 3 illustrates an embodiment wherein the middle frequency ranges are also isolated, and each frequency band may be adjusted with a voltage-controlled amplifier (34-39) (col. 12, lines 25-37). The combination of the low pass filtered components of the two signals, in view of the similar summation of signals in Robinson and the requirements of the subwoofers of Griesinger, equates to "to provide a combined bass frequency signal". The resulting signal, again, in view of the teachings of Griesinger, reads on "electroacoustically transducing the combined signal". The teachings of Robinson and Griesinger, disclose the concept of relatively phase shifting this low pass filtered signal, as is discussed in more detail above.

To one of ordinary skill in the art at the time the invention was made, it would have been obvious to include the low-pass filters in the manner and location taught by Waller into the system of Robinson in view of Griesinger. The motivation behind such a modification would have been that such filters would have provided the sub-woofers of the dual speaker arrangement of the system of Griesinger with a signal including the proper frequency ranges. Such filters would have also enabled frequency range specific signals adjustments to be performed, and be performed to more than one particular frequency range, which parallels the equalization taught by Griesinger.

Regarding Claim 2, the time delay of Robinson is applied to the low frequency range of the processed signal, which reads on "said first frequency range is the bass frequency range". Griesinger also teaches that the phase shift is ideally zero above 400 Hz, which also equates to the bass frequency range (col. 15, lines 27-28).

Regarding Claim 3, the input in Robinson to each of the modifying circuits is derived from the combination of stereo input signals. The upper input signal line (20) shown in Figure 1A receives a summation of two copies of the input stereo signal from a summing network (18) (col. 4, lines 1-4). The forming of this signal on the connection wire (20) reads on "downmixing a third channel and a fourth channel to produce a one of said first channel or said second channel".

Regarding Claim 4, similar to the means discussed in regards to Claim 5, the signal provided on connection line (24) is formed through the subtraction of two copies of an input stereo signal with a difference network (22)(col. 4, lines 1-4 of Robinson). The forming of this signal, based on a copy of the stereo input signal reads on "the step of downmixing a fifth channel and a sixth channel to produce the other of said first channel or said second channel".

Regarding Claim 5, please refer to the like teachings of Claim 3. Regarding Claim 6, please refer to the like teachings of Claim 4.

Regarding Claim 7, Griesinger discloses that all-pass filters are able to provide a nearly constant phase shift in a single decade of frequencies, such as 20Hz to 200 Hz (col. 15, lines 20-23). The concept of performing the phase shift over a particular range of frequencies equates to 'selected so that said relative shifting occurs only over said first frequency range". Figure 15 illustrates a pair of phase shifters being used on two signal lines (col. 15, lines 29-45). This reads on 'a circuit including a first all-pass filter, filtering said audio signal from said first audio channel" and 'a circuit including a second all-pass filter".

Regarding Claim 8, Griesinger teaches that boost stages are utilized in the signal paths to equalize the low and high frequency responses of the output in order to flatten the output response (col. 15, lines 57-65). The gain applied is

approximately 3 db for the low frequency range, and 0 db for the high frequency range (col. 15, lines 62-65). In the system of Robinson, the adjustments to the signal level are applied by a dual channel amplifier (42) before the signal is applied to output speakers (44,46) (col. 4, lines 23-25). The boost applied in the

system of Griesinger, in view of the subwoofers of Griesinger and the amplifier placement of Robinson, reads on 'adjusting the frequency response of the path carrying the combined audio signals".

Regarding Claim 9, the applied signal boost is specifically described by Griesinger as being equalization, which reads on 'said adjusting includes equalizing said combined audio signal" (col. 15, lines 57-65).

Regarding Claim 10, the teachings of Waller include dual low pass filters (22,32), wherein the addition of these two signals involves only the low frequency components of the signals (col. 6, lines 30-32 and 44-48; col. 9, lines 55-57). This summation, in view of the subwoofers of Griesinger, which would have only required the low frequency component of a signal, equates to "said combining combines only the spectral components in said first frequency range".

Regarding Claim 11, please refer above to the rejection of the parallel limitations of Claim 1. Regarding Claim 12, please refer above to the rejection of the parallel limitations of Claim 2, noting that the time delay is applied to the low frequency portion of the signal, and not the other frequency ranges, which reads on "to maintain the phase of said first channel signal relative to said second channel signal unchanged over a second range" (col. 15, lines 27-28 of Griesinger). Regarding Claim 13, please refer to the like teachings of Claim 2, again noting that the time delay is applied to the low frequency part of the signal. Regarding Claim 14, please refer to the like teachings of Claim 1. Regarding Claim 15, please refer to the like teachings of Claim 7. Regarding Claim 16, please refer to the like teachings of Claim 7. Regarding Claim 17, please refer to the like teachings of Claim 2.

Regarding Claim 20, Waller discloses the use of two low pass filters (22,32) for filtering the two signals in the two derived signal paths (col. 6, lines 28-30 and 44-48). These filters equate to "a first low-pass filter for filtering said first audio signal and a second low pass filter for filtering said second audio signal". The combination of these two specific signals in the adders of Waller, in view of the requirement of the subwoofer speaker of Griesinger, read on "so that said combiner combines only the bass portions of said first audio signal and said second audio signal".

Regarding Claim 22, please refer to the like teachings of Claim 3. Regarding Claim 23, please refer to the like teachings of Claim 1. Pp.4-13.

"The mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification." *In re Gordon*, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984). As the Federal Circuit Court of Appeals said in *In re Dembiczak*, 175 F.3d 994, 999 (Fed. Cir. 1999):

> Close adherence to this methodology is especially important of less technologically complex inventions, where the very ease with which the invention can be understood may prompt one 'to fall victim to the insidious effect of a

hindsight syndrome wherein that which only the inventor taught is used against its teacher.'

And in *In re Kotzab*, 55 U.S.P.Q.2d 1313, 1316 (Fed. Cir. 2000), the Court said:

> [I]dentification in the prior art of each individual part claimed is insufficient to defeat patentability of the whole claimed invention. See id. [Dembiczak]. Rather, to establish obviousness based on a combination of the elements disclosed in the prior art, there must be some motivation, suggestion or teaching of the desirability of making the specific combination that was made by the applicant. See In re Dance, 160 F.3d 1339, 1343, 48 U.S.P.Q.2d 1635, 1637 (Fed. Cir. 1998), In re Gordon, 733 F.2d 900, 902, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984). Even when obviousness is based on a single prior art reference, there must be a showing of a suggestion or motivation to modify the teachings of that reference. See *B. F. Goodrich Co. v. Aircraft Braking Sys. Corp.*, 72 F.3d 1577, 1582, 37 U.S.P.Q.2d 1314, 1318 (Fed. Cir. 1996).

The primary reference fails to disclose the substantially constant phase shift called for by all these rejected claims, but discloses using time delay. Using time delay to introduce phase shift as shown in FIG. 2 of the primary reference induces phase shift that is a function of frequency (col. 4, lines 35-41). An advantage of the claimed invention calling for substantially constant phase shift is the desirable property of producing a similar boost in the output, regardless of the phase and correlation relationship of the input signals as explained on page 6, lines 14-16 and 23-29 of the written description.

The secondary reference does not overcome the shortcomings of the primary reference in disclosing driving separate speakers with a 90 degree phase shift. Nor does the tertiary reference, which discloses decoding non-encoded stereo channels into at least four-channel sound, overcome the deficiency of the primary reference.

It is thus impossible to combine the primary, secondary and tertiary references to meet the limitations of these rejected claims. "Moreover, we observe that even if these references were combined in the manner proposed by the examiner, that which is set forth in appellant's claims . . . would not result." *Ex parte Bogar*, slip op. p.7 (BPA&I Appeal No. 87-2462, October 27, 1989). "Even if we were to agree with the examiner that it would have been obvious to combine the reference teachings in the manner proposed, the resulting package still would not comprise zipper closure material that terminates short of the end of the one edge of the product

containing area, as now claimed." *Ex parte Schwarz*, slip op. p.5 (BPA&I Appeal No. 92-2629 October 28, 1992). "Although we find nothing before us indicating why it would be desired to combine the references in the manner urged by the examiner, it is clear to us that such a modification by itself would not result in that which is set forth in the claims." *Ex Parte Kusko*, 215 U.S.P.Q. 972, 974 (BPA&I 1981). That it is impossible to combine the references to meet the terms of the rejected claims is reason enough for withdrawing the rejection of them.

If this ground of rejection is maintained, the Examiner is respectfully requested to quote verbatim the language in the references regarded as corresponding to each limitation in each rejected claim, and quote verbatim the language in the references regarded as suggesting the desirability of combining what is there disclosed to meet the limitations of these rejected claims.

III. CLAIM 21 MEETS THE CONDITIONS FOR PATENTABILITY UNDER 35 U.S.C.§103(A) BECAUSE THE PRIMARY, SECONDARY, TERTIARY AND QUATERNARY REFERENCES DO NOT SUGGEST THE DESIRABILITY OF COMBINING WHAT IS THERE DISCLOSED TO MEET THE LIMITATIONS OF CLAIM 21.

The final action states:

> 5. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Robinson in view of Griesinger and Waller, as applied above, and in further view of Kuusama et al (USPN 6332026). Hereafter, "Kuusama et al" will simply be referred to as "Kuusama".
>
> As detailed above, Robinson discloses circuitry for improving the low frequency output of a stereo speaker system, in which the improvement involves the phase shifting of one processed signal in regards to another. Griesinger specifies desired frequency shifts for corresponding frequency ranges that improves the apparent speciousness of a low frequency portion of an audio signal. Griesinger discloses a particular speaker arrangement that utilizes subwoofers, which would have only required the low frequency component of a signal for output. Waller discloses the use of low pass filters for isolating the low frequency component of an audio signal for processing. Robinson in view of Griesinger and Waller does not specify:
>
> - a low pass filter that filters the output of the combiner for providing only the bass component of the combined signal
>
> Kuusama discloses a system for deriving a low frequency effect audio signal. Such a system involves the low pass filtering of a combination of the surround input signals, and combining the filtered signal with a subwoofer signal, and then providing the modified signal as output or for use in combination with other channel signals (col. 4, lines 64-67 and col. 5, lines 1-16). The combined signal in the system of Kuusama is low pass filtered (9), which reads on 'a low

> pass filter for filtering the output signal of said combiner to provide only the bass portion of said combined signal" (col. 5, lines 5-8).
>
> To one of ordinary skill in the art at the time the invention was made, it would have been obvious to include the low pass filter in the manner of Kuusama into the system of Robinson in view of Griesinger and Waller. The motivation behind such a modification would have been that such a filter would have ensured that the appropriate frequency range of a signal applied to a subwoofer. Such a filter would have provided an alternative manner of filtering to that taught by Waller, or would have redundantly ensured that the output signal contains the proper frequency range. Pp.13-14.

Claim 21 is dependent upon and includes all the limitations of claim 14, and the reasoning set forth above in support of the patentability of claim 14 over the primary, secondary, and tertiary references is submitted to support the patentability of claim 21 over the primary, secondary, tertiary and quaternary references so that further discussion of the quaternary reference is submitted to be unnecessary. It is impossible to combine the references to meet the limitations of claim 21, and that is reason enough for withdrawing the rejection of it.

CONCLUSION

In view of the forgoing authorities, remarks and the inability of the prior art, alone or in combination, to anticipate, suggest or make obvious the subject matter as a whole of the invention disclosed and claimed in this application, the decision of the Examiner finally rejecting claims 1-23 should be reversed. If the Board is of opinion that a claim may be allowed in amended form, the Board is respectfully requested to include an explicit statement to that effect and direct that appellant shall have the right to amend in conformity with such statement which shall be binding on the Examiner in the absence of new reference or grounds of rejection.

Please apply any charges not covered or any credits to Deposit Account No. 06-1050, Order No. 02103-397001. A check to cover the brief fee of $500 is enclosed.

Respectfully submitted,
FISH & RICHARDSON P.C.

Date: DEC 23 2004

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Encl: Drawings

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(viii) Claims appendix.

1. A method for combining a first audio signal from a first audio channel and a second audio signal from a second audio channel, said first and second audio signals having a first and second frequency range, comprising:

shifting the phase of said first audio signal relative to said second audio signal, wherein said shifting is constant and substantially limited to said first frequency range from about 20 Hz to about 500 Hz; and

combining the relatively phase-shifted audio signal from said first channel with the audio signal from said second channel to provide a combined bass frequency signal with the range of phase shifting being between about 60 degrees and about 120 degrees,

and electroacoustically transducing the combined bass signal.

2. A method for combining audio signals in accordance with claim 1, wherein said first frequency range is the bass frequency range.

3. A method for combining audio signals in accordance with claim 2, further comprising downmixing a third channel and a fourth channel to produce a one of said first channel or said second channel.

4. A method for combining audio signals in accordance with claim 3, further comprising the step of downmixing a fifth channel and a sixth channel to produce the other of said first channel or said second channel.

5. A method for combining audio signals in accordance with claim 1, further comprising downmixing a third channel and a fourth channel to produce a one of said first channel or said second channel.

6. A method for combining audio signals in accordance with claim 5, further comprising the step of downmixing a fifth channel and a sixth channel to produce the other of said first channel or said second channel.

7. A method for combining audio signals in accordance with claim 1, wherein said relative shifting involves applying said first audio signal to a circuit including a first all-pass filter, filtering said audio signal from said first audio channel, and applying said second audio signal to a circuit including a second all-pass filter, filtering said second audio signal from said second audio channel, wherein parameters of said first all-pass filter and parameters of said

second all-pass filter are selected so that said relative shifting occurs only over said first frequency range.

8. A method for combining audio signals in accordance with claim 1, further comprising adjusting the frequency response of the path carrying the combined audio signals.

9. A method for combining audio signals in accordance with claim 8 wherein said adjusting includes equalizing said combined audio signal.

10. A method for combining audio signals in accordance with claim 1, wherein said combining combines only the spectral components in said first frequency range.

11. An audio system comprising:

an audio signal source constructed and arranged to provide a first channel signal and a second channel signal;

a phase shifter, coupled to said audio signal source for shifting by a constant phase angle the phase of said first channel signal relative to said second channel signal, wherein said phase shifter is constructed and arranged to substantially limit said phase shifting to said first range of frequencies, only over a first range of frequencies between about 20 Hz to about 500 Hz with the range of phase shifting between 60 degrees to about 120 degrees,

a combiner constructed and arranged to combine the relatively phase-shifted first channel signal and second channel signal to provide a combined bass signal,

and electroacoustical transducing apparatus constructed and arranged to transduce the combined bass signal.

12. An audio system in accordance with claim 11, is constructed and arranged to maintain the phase of said first channel signal relative to said second channel signal unchanged over a second range of frequencies.

13. An audio system in accordance with claim 12, wherein said first range of frequencies is lower than said second range of frequencies.

14. An audio system, comprising:

a first audio channel input for providing a first audio signal;

a second audio channel input for providing a second audio signal;

phase shifting circuitry, coupled to said first audio channel input and said second

audio channel input, for shifting the phase of said first audio signal relative to said second audio signal by a constant phase angle over a first range of frequencies to produce a partially phase shifted audio signal between about 20 Hz to about 500 Hz with the range of phase shifting between about 60 degrees to about 120 degrees, and

a combiner, for combining said partially phase shifted first audio signal and said second audio signal to produce a combined bass audio signal,

and electroacoustical transducing apparatus constructed and arranged to transduce the combined bass audio signal into radiated bass acoustic signal.

15. An audio system in accordance with claim 14, said phase shifting circuitry includes a first all-pass filter coupling said first audio channel input and said combiner,

said first all pass filter having first filter parameters, and

a second all pass filter coupling said second audio channel input and said combiner,

said second all pass filter having second filter parameters.

16. An audio system in accordance with claim 15, wherein said first filter parameters and said second filter parameters are predetermined so that said phase shifting circuitry shifts the phase of said first audio signal relative to said second audio signal only over said first range of frequencies.

17. An audio system in accordance with claim 16, wherein said first range of frequencies is limited to the bass frequency band.

18. An audio system in accordance with claim 15, further comprising a third all-pass filter coupling said first all-pass filter and said combiner,

said third all-pass filter having third filter parameters

and a fourth all-pass filter coupling said second all-pass filter and said combiner,

said fourth all-pass filter having fourth filter parameters,

wherein said first and third all-pass filters have a frequency spacing of approximately 16 and wherein said second and fourth all-pass filters have a spacing of approximately 16.

19. An audio system in accordance with claim 15, further comprising a third all-pass filter coupling said first all pass filter and said combiner,

said third all-pass filter having third filter parameters,

and a fourth all-pass filter coupling said first all-pass filter and said combiner,

said fourth all-pass filter having fourth filter parameters,

wherein the combination of said first and third all-pass filters have a frequency spacing factor relative to the combination of said second and fourth all-pass filters of between three and five.

20. An audio system in accordance with claim 14, further comprising a first low-pass filter for filtering said first audio signal and a second low-pass filter for filtering said second audio signal so that said combiner combines only the bass portions of said first audio signal and said second audio signal.

21. An audio system in accordance with claim 14, further comprising a low-pass filter for filtering the output signal of said combiner to provide only the bass portion of said combined signal.

22. An audio system in accordance with claim 14, further comprising a downmixing circuit for downmixing signals in a third channel and a fourth channel to form said first audio signal.

23. An audio system in accordance with claim 14, wherein said combiner combines said partially phase-shifted first audio signal and said second audio signal only in said first range of frequencies.

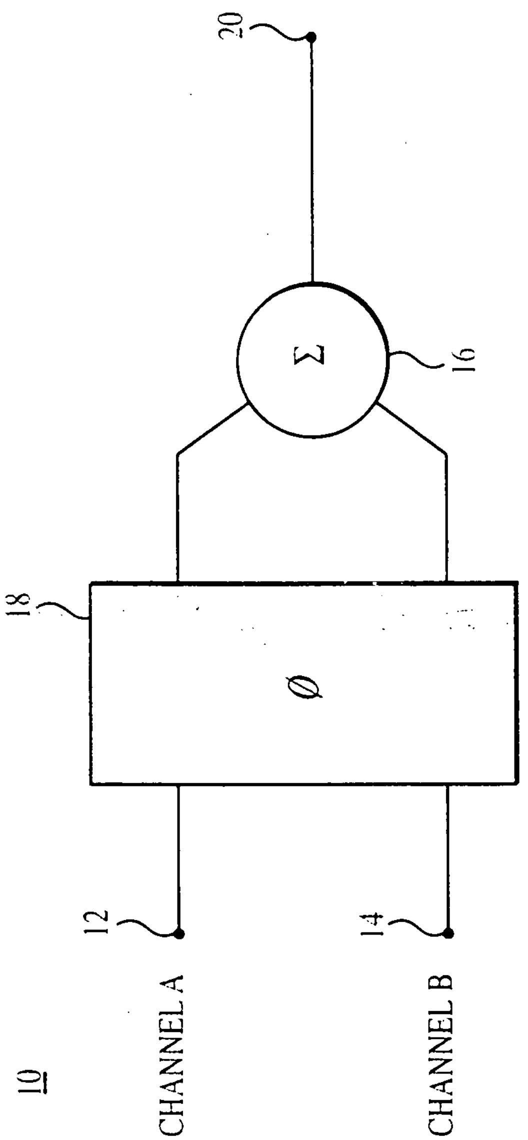

FIG. 1

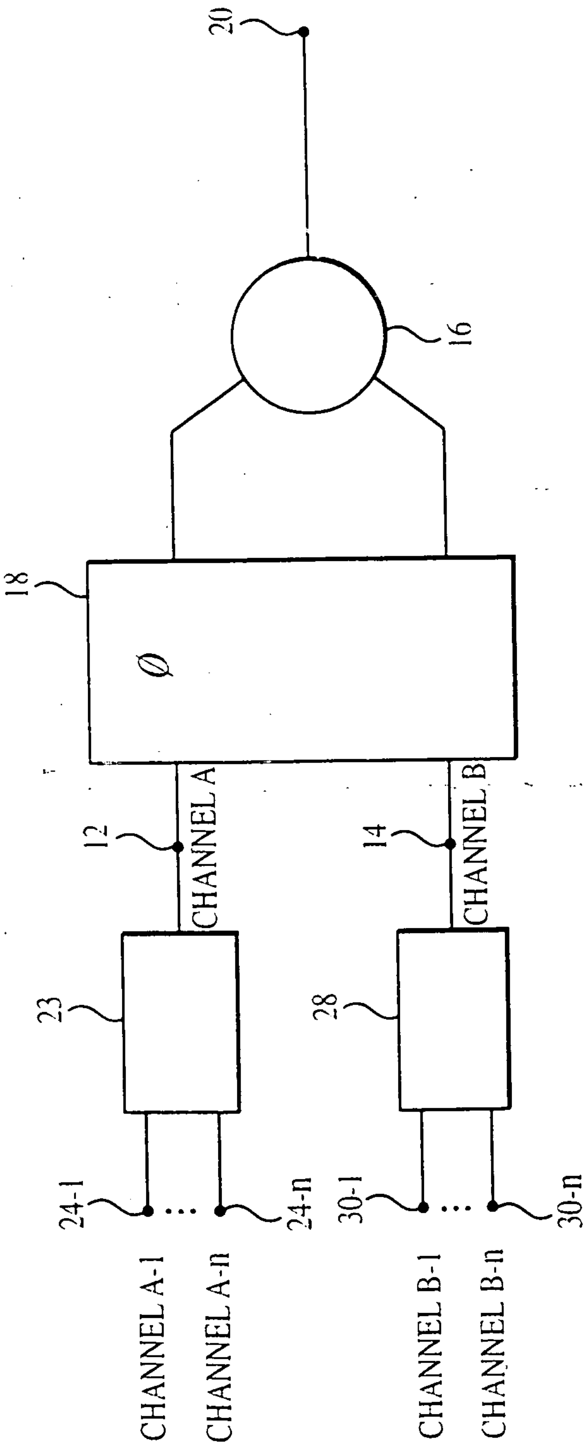
20
16
18
Ø
12
CHANNEL A
14
CHANNEL B
23
28
24-1
24-n
30-1
30-n
CHANNEL A-1
CHANNEL A-n
CHANNEL B-1
CHANNEL B-n

FIG. 2a

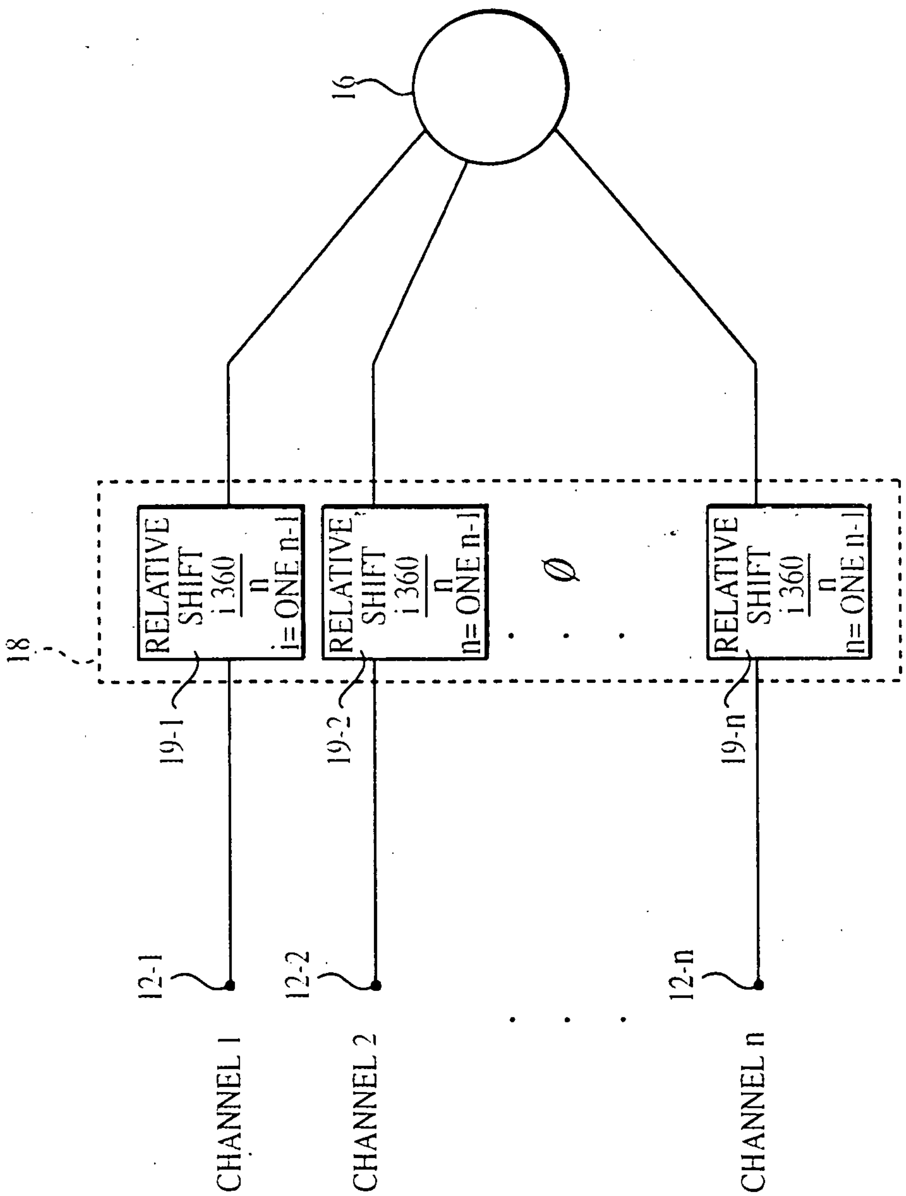
16
18
RELATIVE SHIFT i 360 / n i= ONE n-1
RELATIVE SHIFT i 360 / n n= ONE n-1
Ø
RELATIVE SHIFT i 360 / n n= ONE n-1
19-1
19-2
19-n
12-1
12-2
12-n
CHANNEL 1
CHANNEL 2
CHANNEL n

FIG. 2b

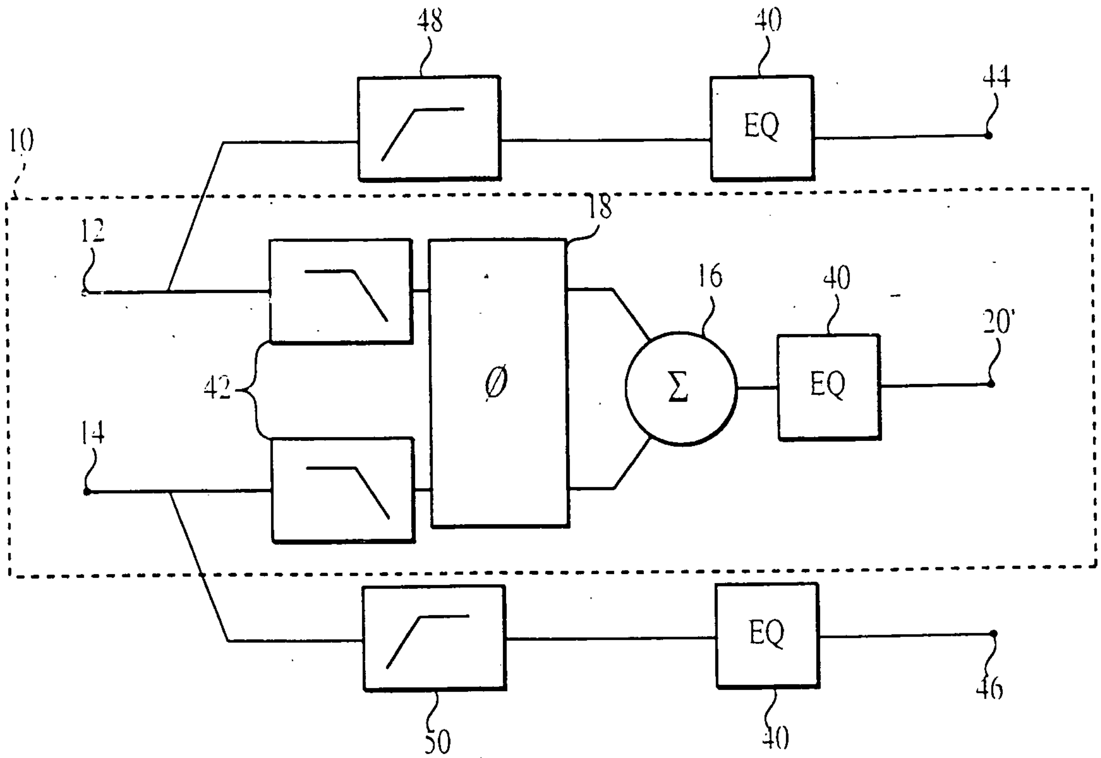
48
40
44
10
EQ
18
12
16
40
20'
42
Ø
Σ
EQ
14
EQ
46
50
40

FIG. 3a

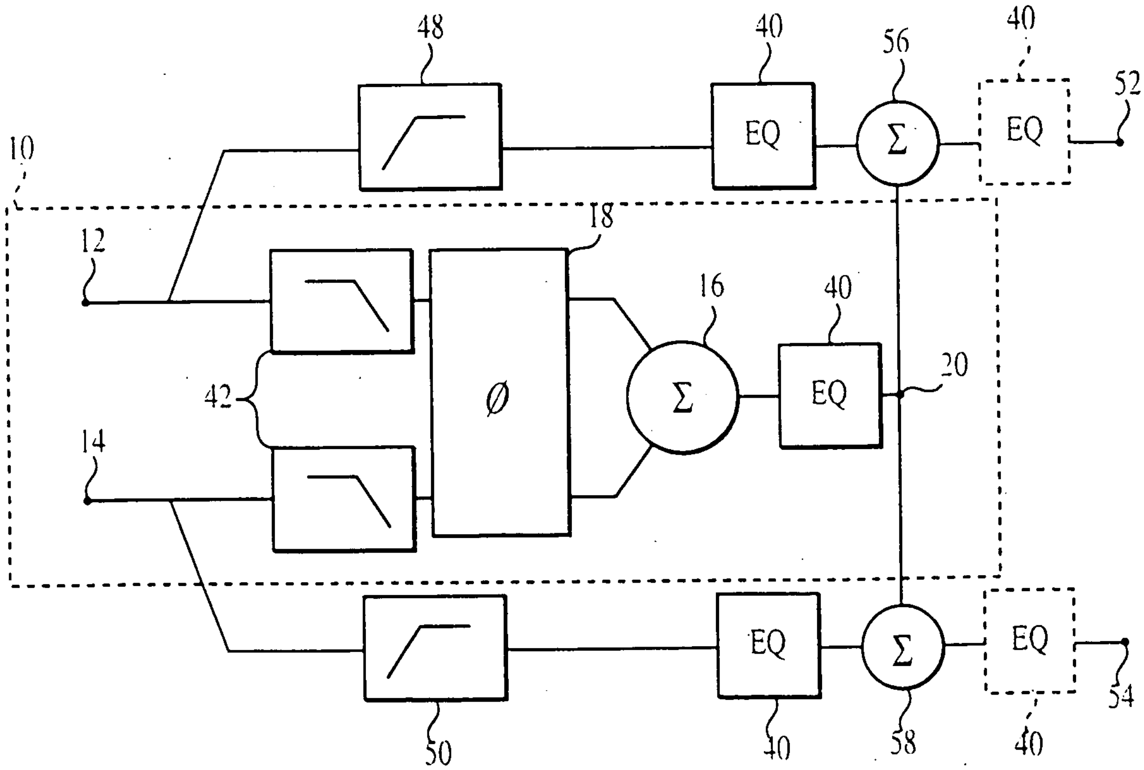
48
40
56
40
52
10
EQ
Σ
EQ
18
12
16
40
20
42
Ø
Σ
EQ
14
EQ
Σ
EQ
54
50
40
58
40

FIG. 3b

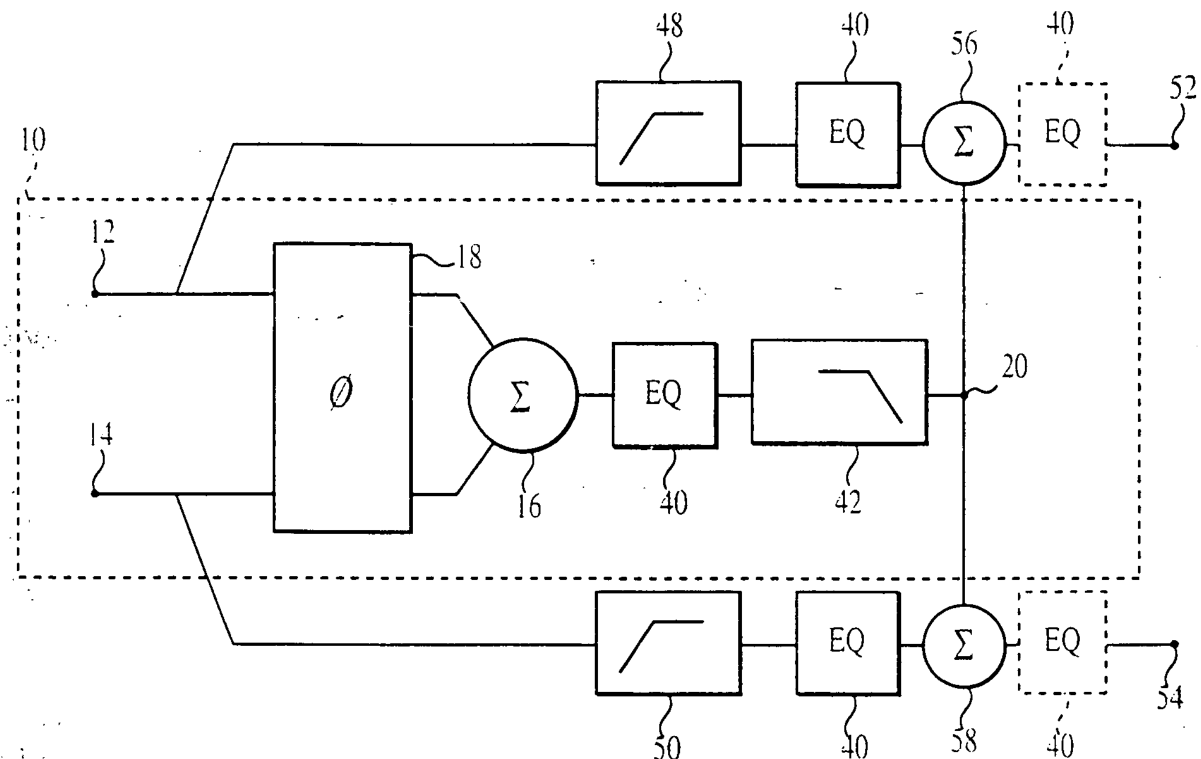
48
40
56
40
52
10
EQ
Σ
EQ
12
18
Ø
Σ
EQ
20
14
16
40
42
EQ
Σ
EQ
54
50
40
58
40

FIG. 3c

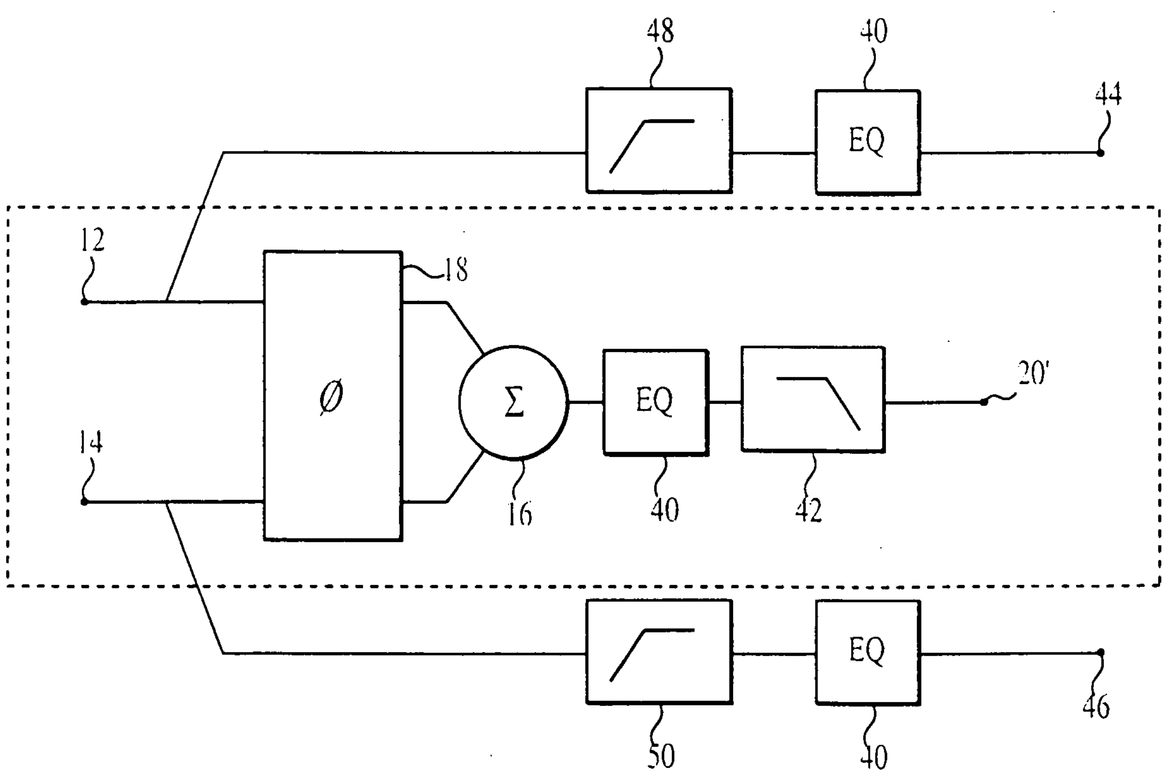
48
40
44
EQ
12
18
Ø
Σ
EQ
20'
14
16
40
42
EQ
46
50
40

FIG. 3d

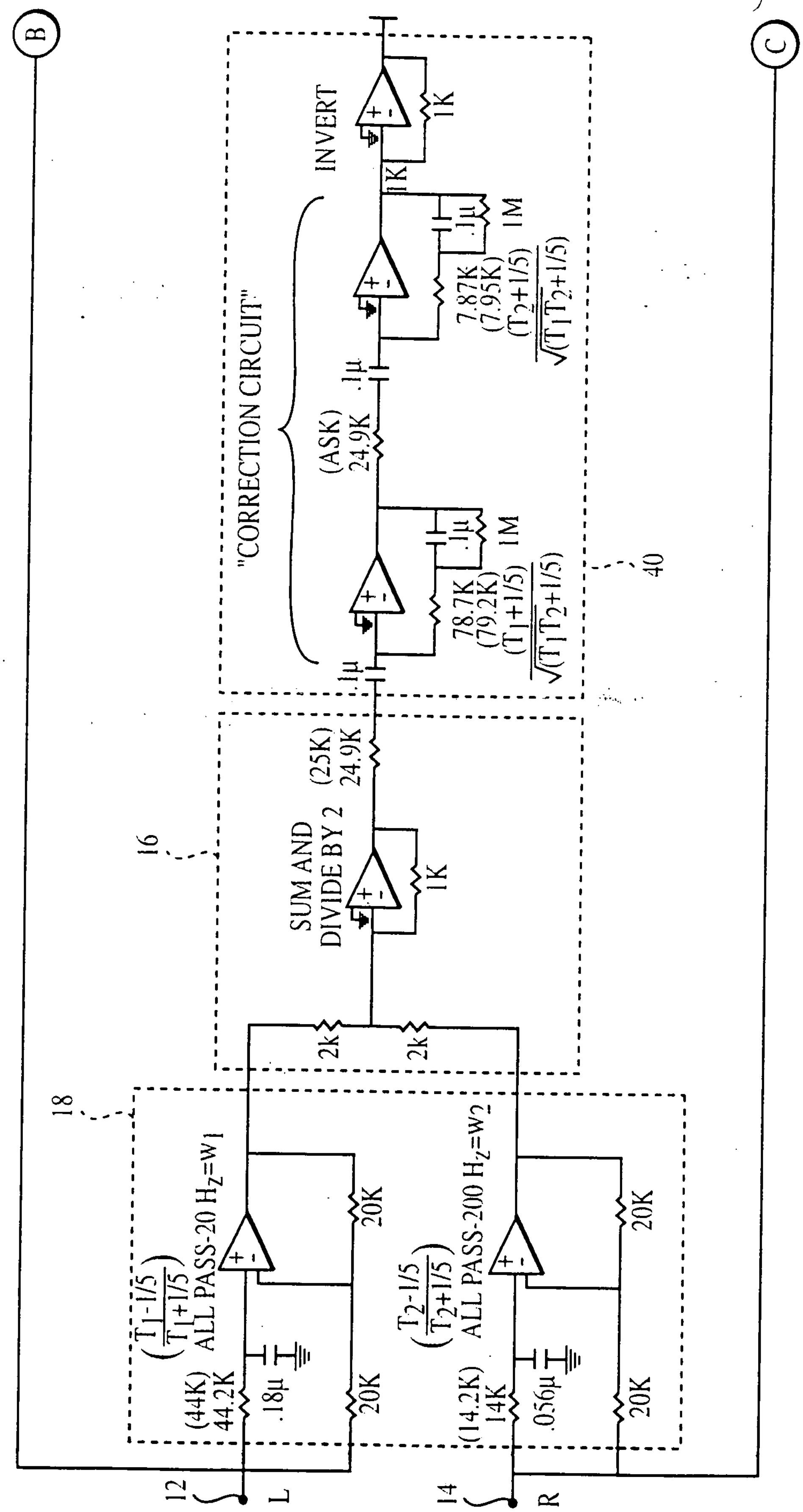
B
C
INVERT
1K
1K
1M
.1µ
7.87K
(7.95K)
"CORRECTION CIRCUIT"
(ASK)
24.9K
.1µ
1M
.1µ
78.7K
(79.2K)
.1µ
40
16
SUM AND
DIVIDE BY 2
(25K)
24.9K
1K
2K
2K
18
ALL PASS-20 Hz=W1
20K
20K
(44K)
44.2K
.18µ
ALL PASS-200 Hz=W2
20K
20K
(14.2K)
14K
.056µ
12
L
14
R

FIG. 4a

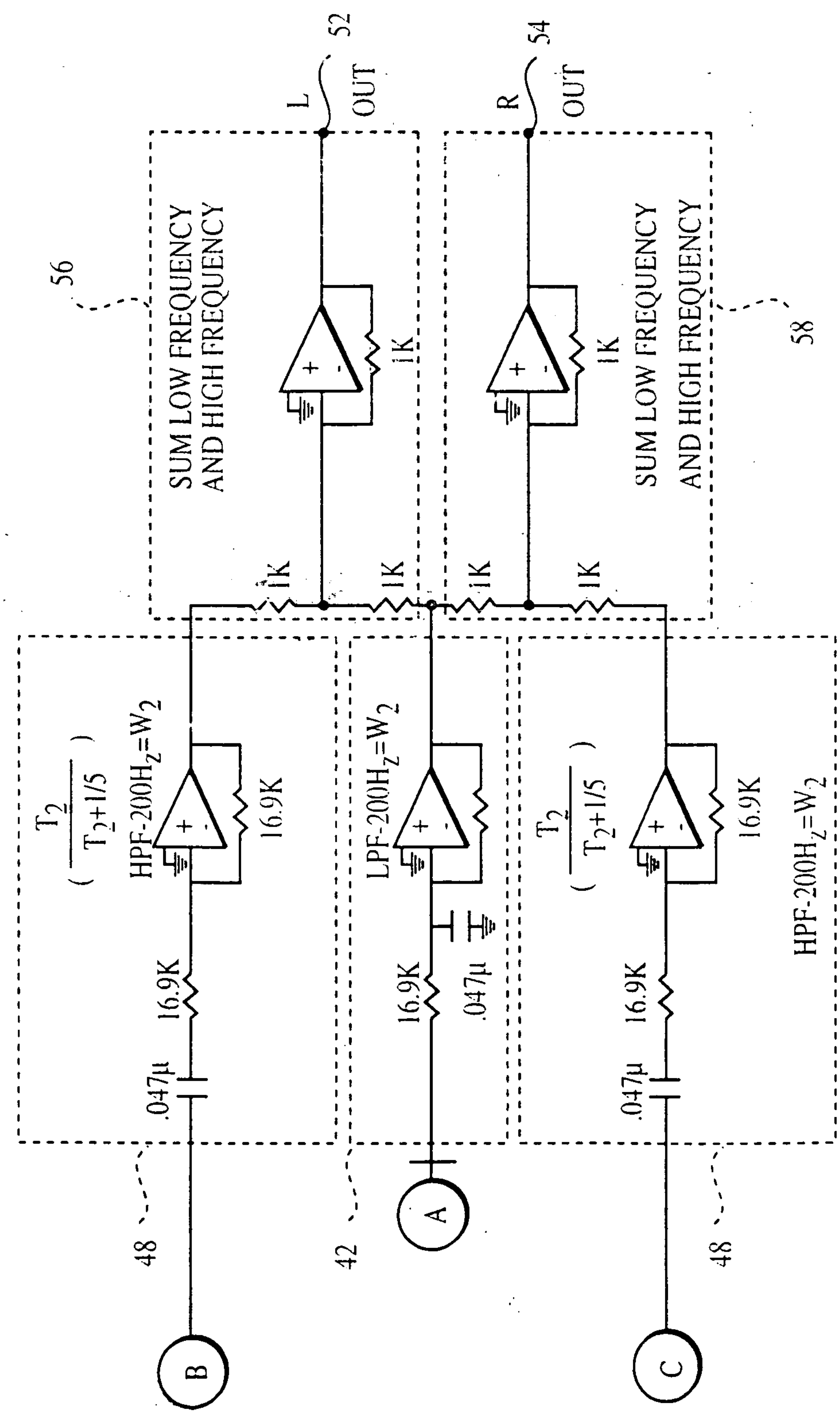
L
OUT
52
R
OUT
54
56
SUM LOW FREQUENCY
AND HIGH FREQUENCY
58
SUM LOW FREQUENCY
AND HIGH FREQUENCY
1K
1K
1K
1K
1K
1K
$\left(\frac{T_2}{T_2+1/5}\right)$
HPF-200Hz=W2
16.9K
16.9K
.047μ
LPF-200Hz=W2
16.9K
.047μ
$\left(\frac{T_2}{T_2+1/5}\right)$
HPF-200Hz=W2
16.9K
16.9K
.047μ
48
42
48
A
B
C

FIG. 4b

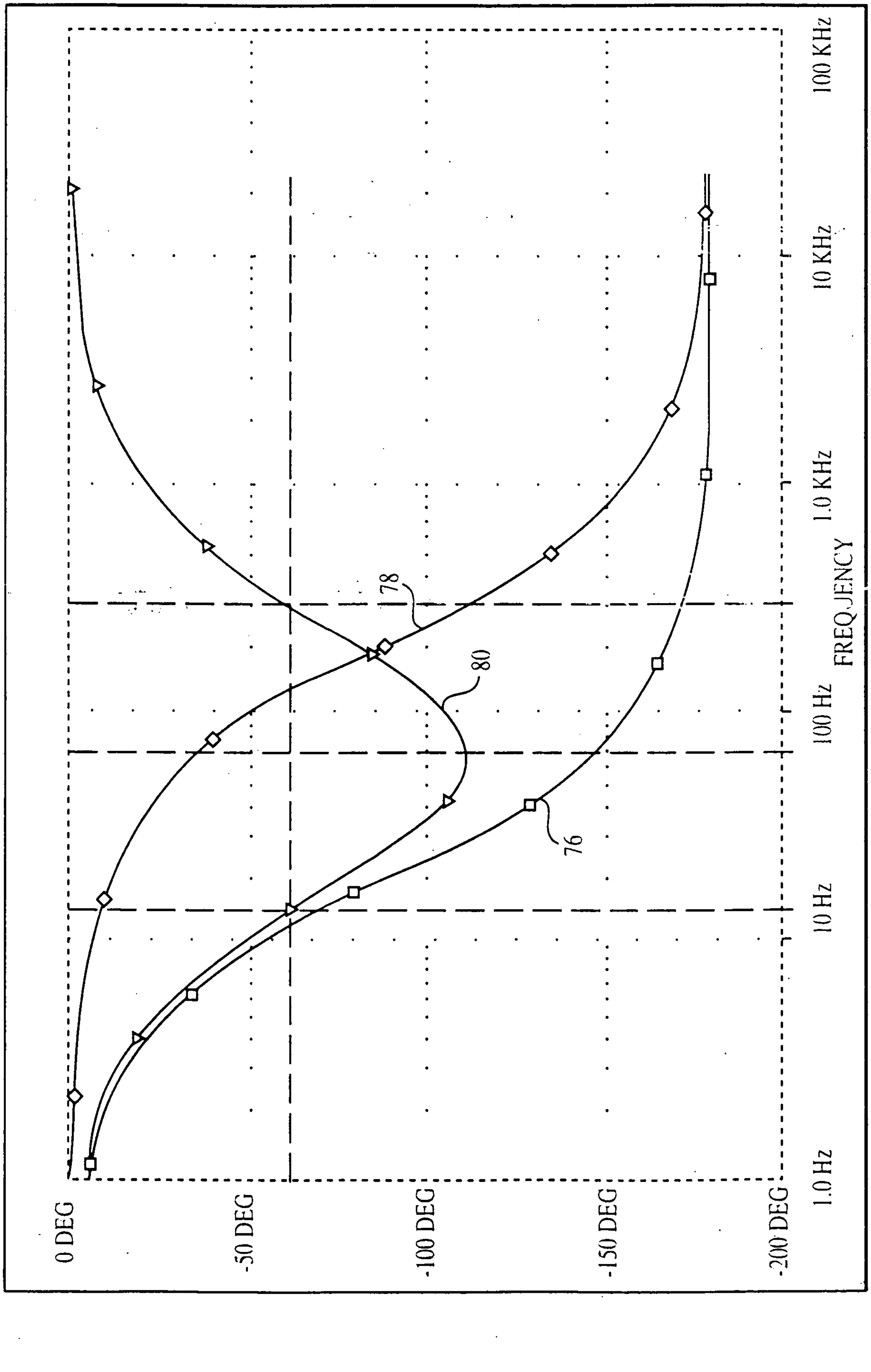
0 DEG
-50 DEG
-100 DEG
-150 DEG
-200 DEG
1.0 Hz
10 Hz
100 Hz
1.0 KHz
10 KHz
100 KHz
FREQUENCY
76
78
80

FIG. 5a

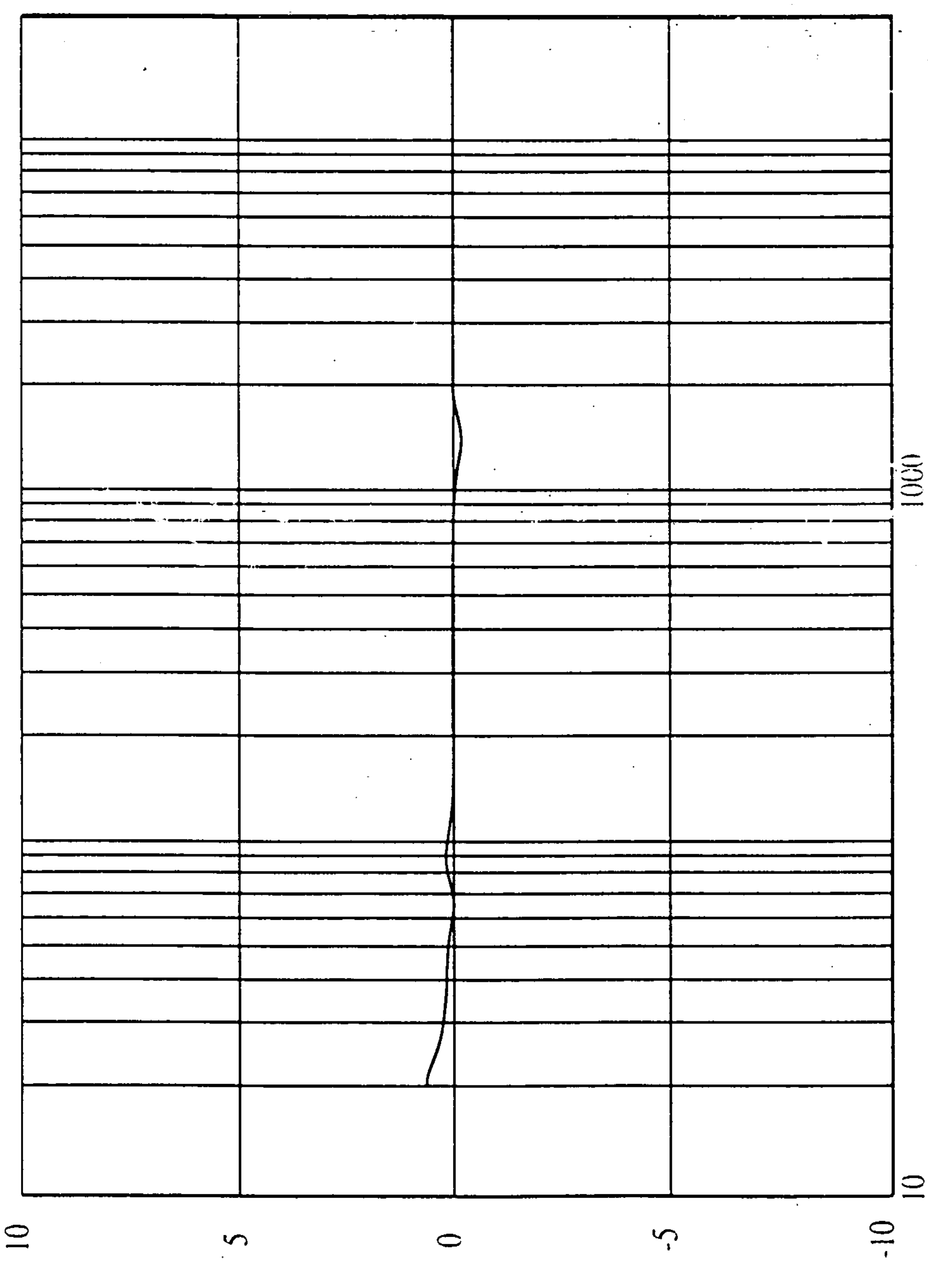

FIG. 5b

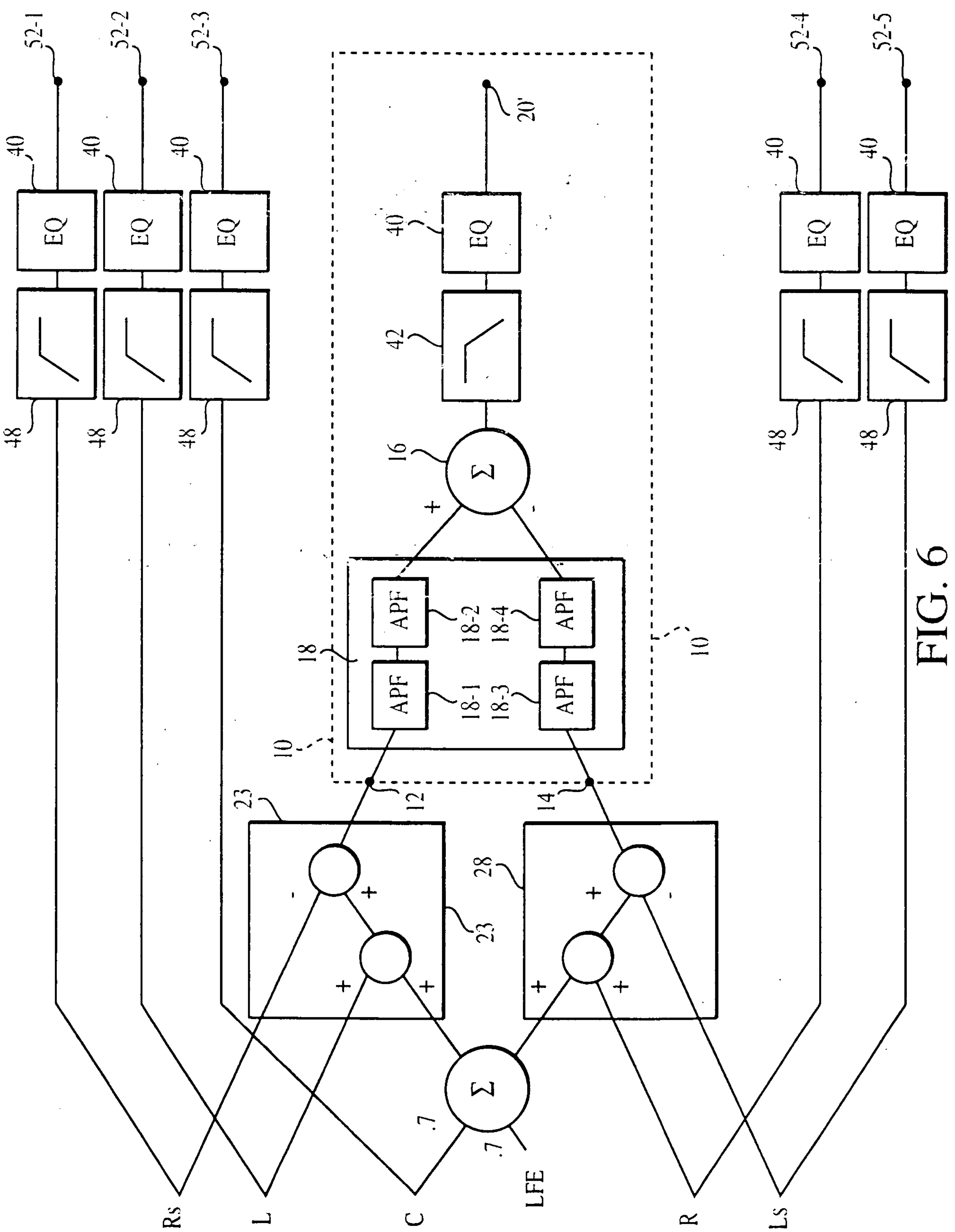
52-1
52-2
52-3
52-4
52-5
40
EQ
48
42
20'
16
Σ
+
-
APF
18
18-1
18-2
18-3
18-4
10
12
14
23
28
.7
Rs
L
C
LFE
R
Ls

FIG. 6

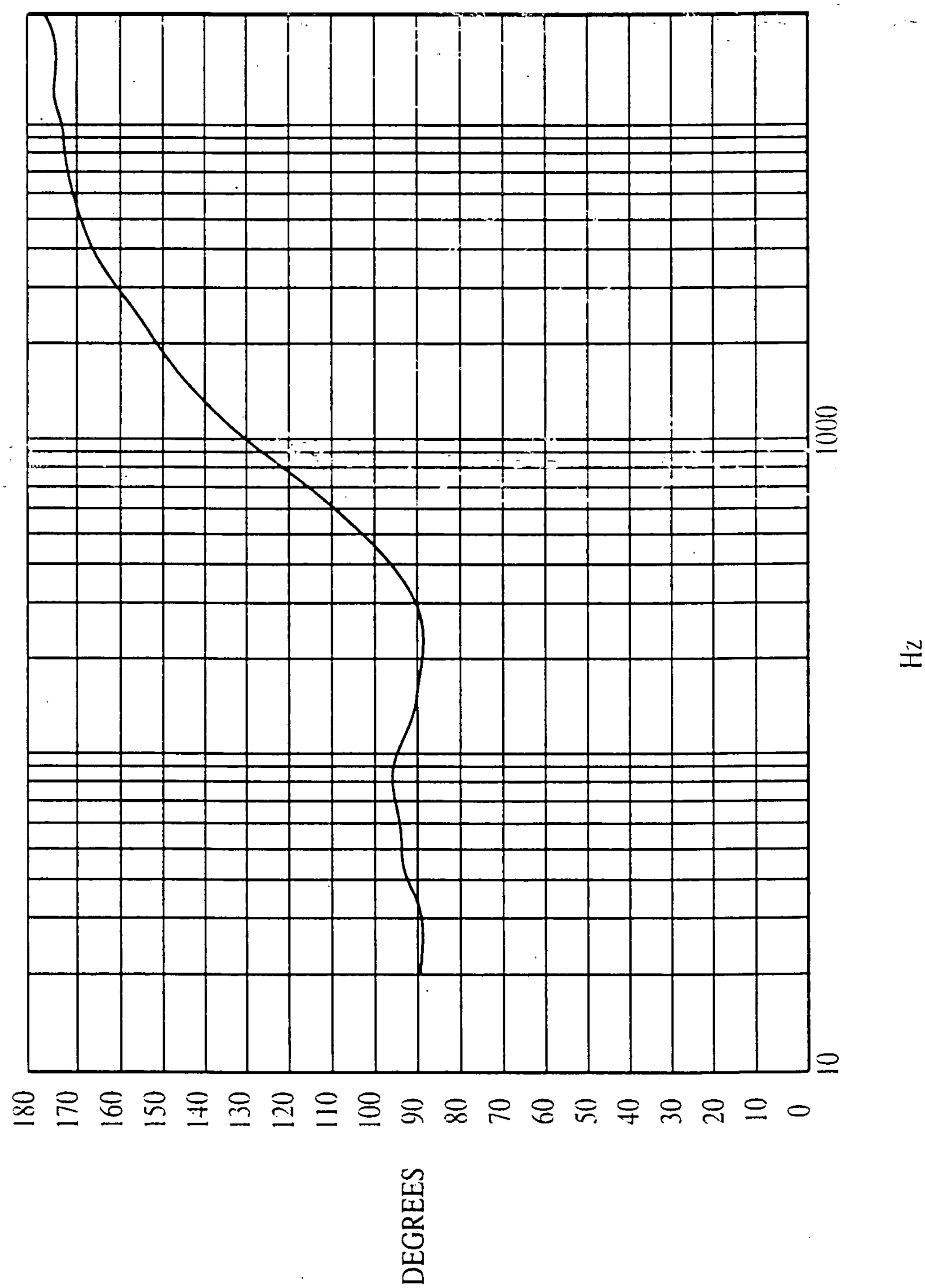
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
DEGREES
10
1000
Hz

FIG. 7a

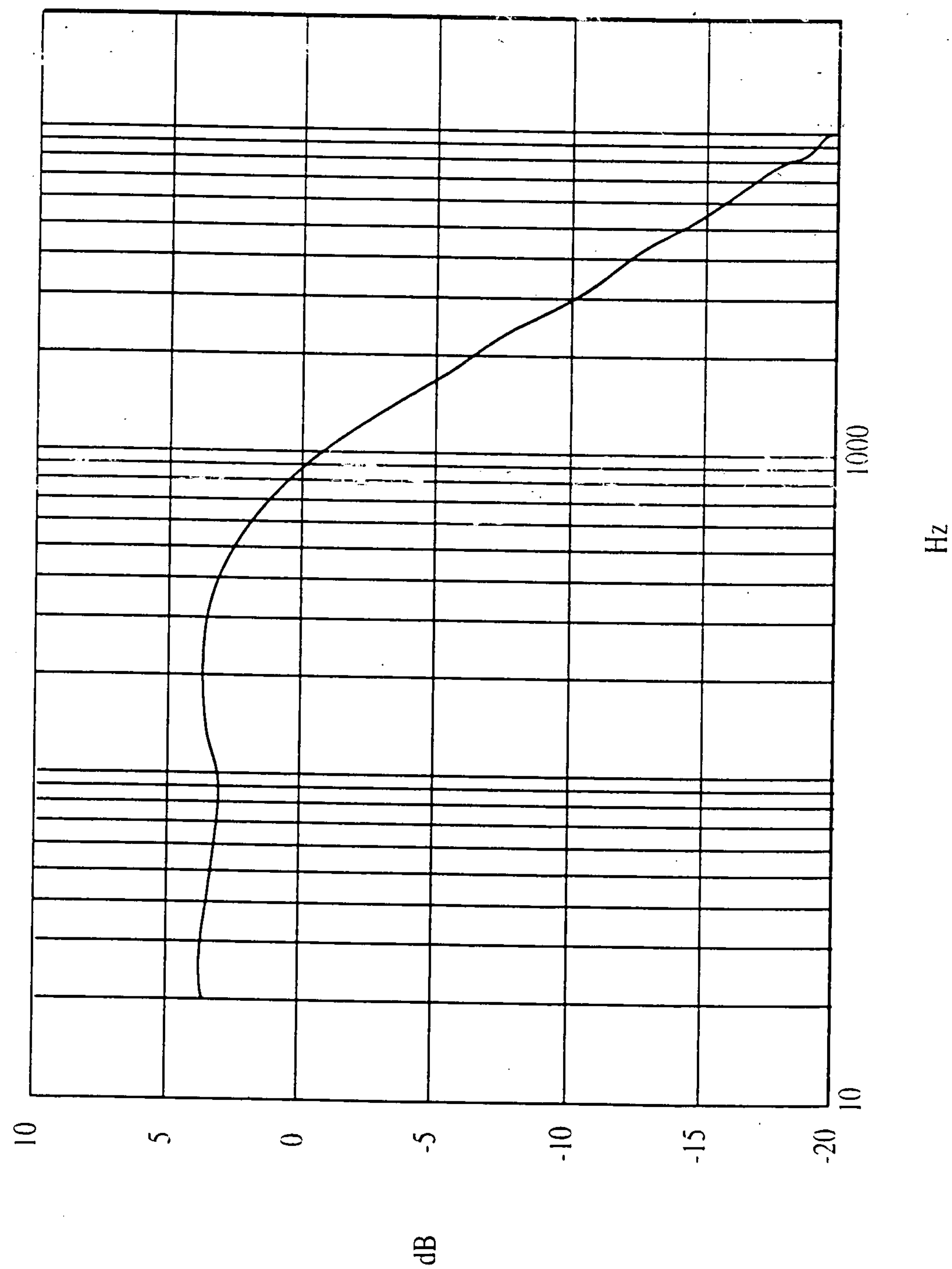

FIG. 7b

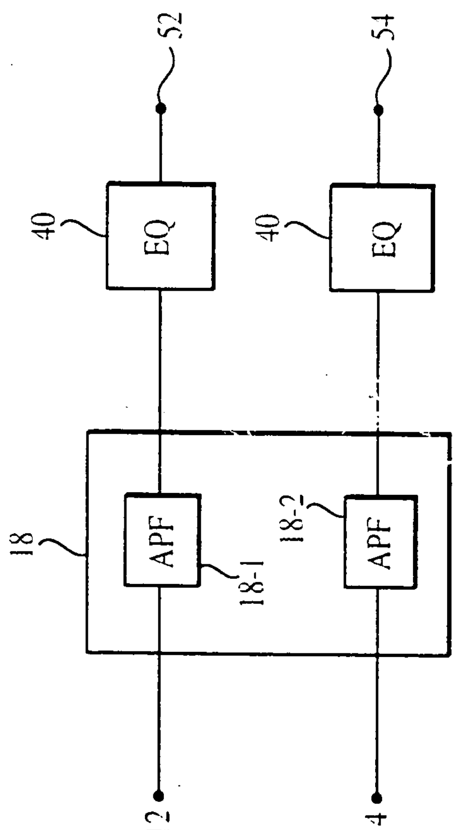

FIG. 8a

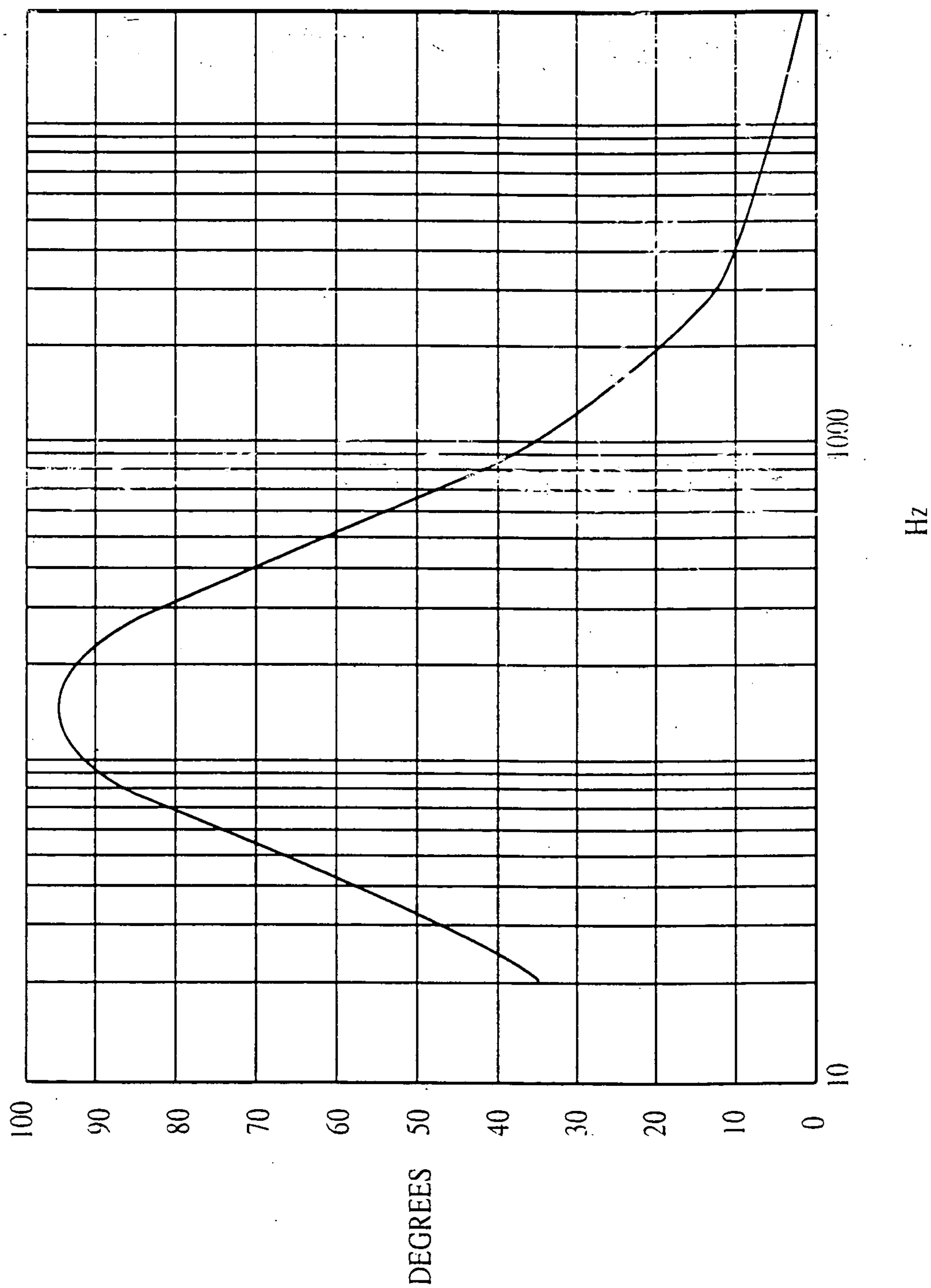

FIG. 8b

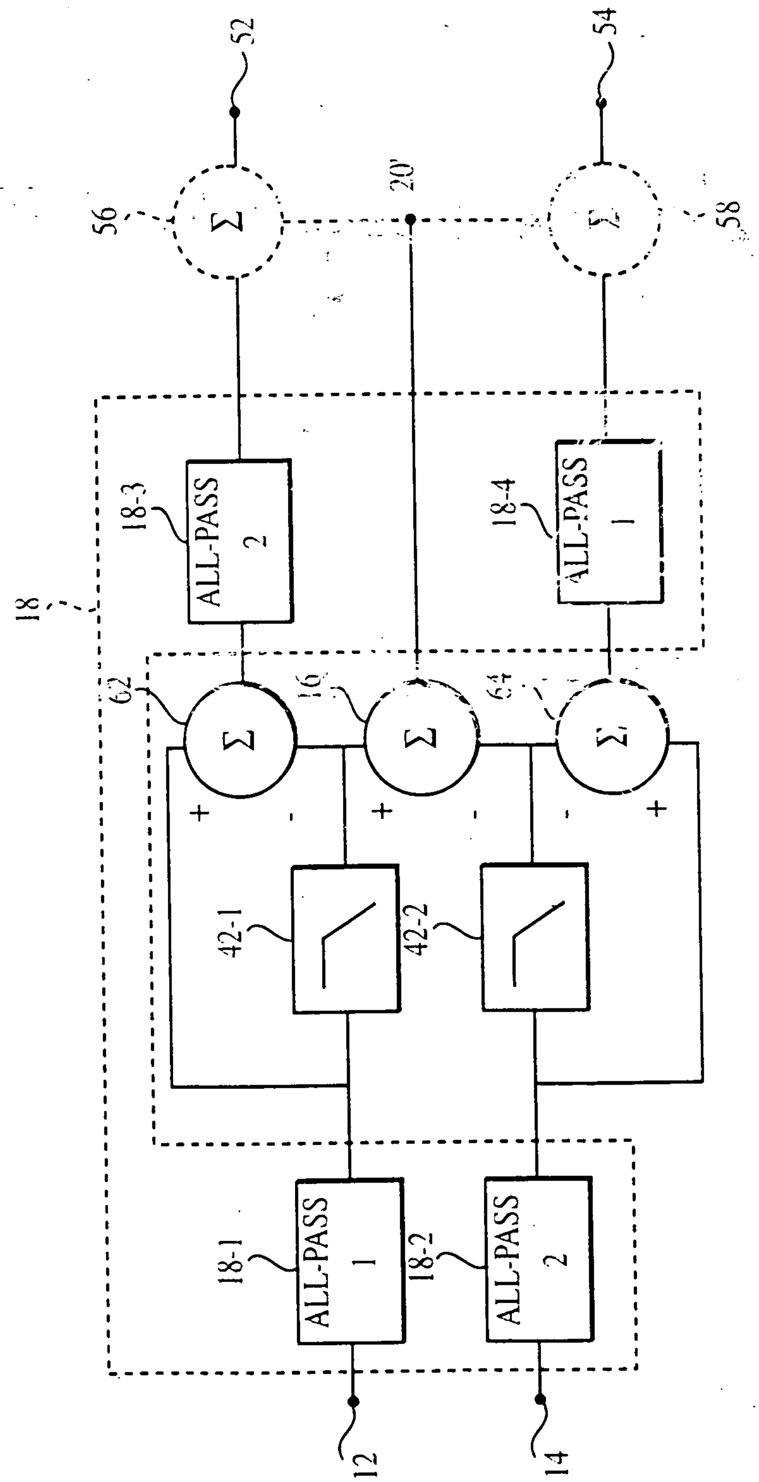
52
54
56
58
20'
18
18-3
ALL-PASS 2
18-4
ALL-PASS 1
62
16
64
42-1
42-2
18-1
ALL-PASS 1
18-2
ALL-PASS 2
12
14

FIG. 9